# *Announcements*

- Homework for tomorrow…

  (Ch. 26, CQ 3, Probs. 8 & 36)

CQ12: 


25.22: $q = 1.1 \times 10^{-10}$ C
25.60: see handout
25.66: $q = 1.8 \times 10^{-7}$ C

Office hours…

MW 10-11 am
TR 9-10 am
F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm
  F 8-11 am, 2-5 pm
  Su 1-5 pm

# Chapter 26

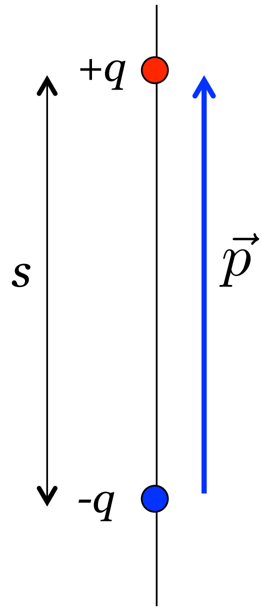
## The Electric Field

(*The E-Field of a Continuous Charge Distribution*)

# *Last time…*

- *Dipole Moment…*

$$\boxed{\vec{p} = qs, \text{ from the - to + charge}}$$




- *E-field* of a dipole on the *dipole axis…*

$$\boxed{\vec{E}_{dipole} \simeq \frac{1}{4\pi\epsilon_0}\frac{2\vec{p}}{r^3}} \quad \text{when } r \gg s$$

- *E-field* of a dipole in the *bisecting plane…*

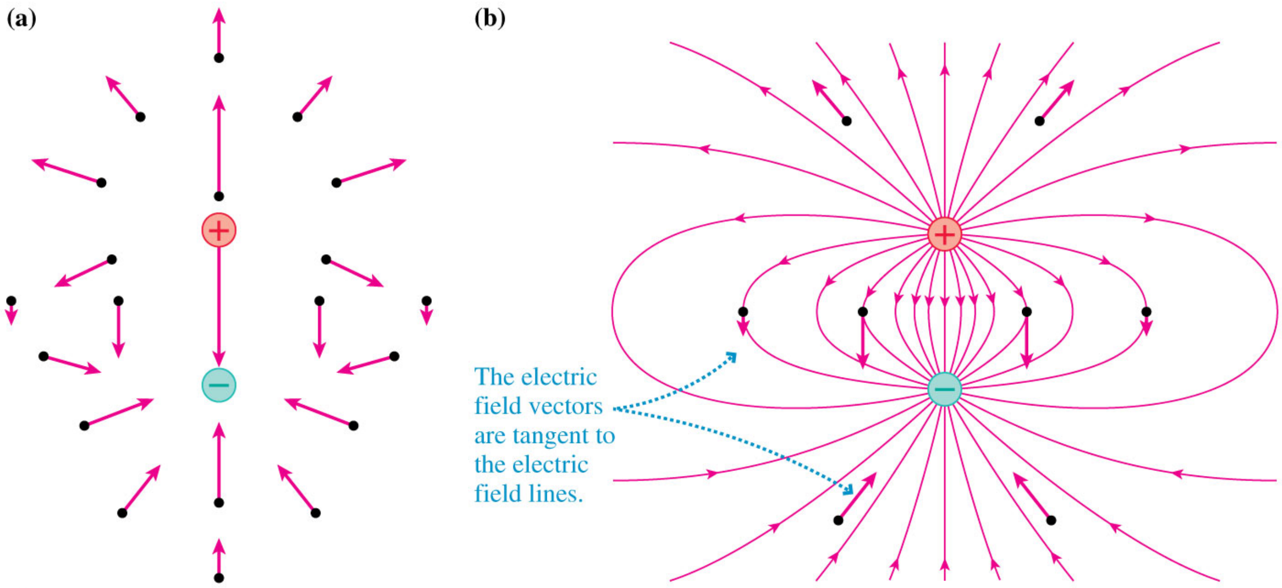
$$\boxed{\vec{E}_{dipole} \simeq -\frac{1}{4\pi\epsilon_0}\frac{\vec{p}}{r^3}} \quad \text{when } r \gg s$$

*Notice*: *r* is distance measured from the *center* of dipole.

# Picturing the E-Field…

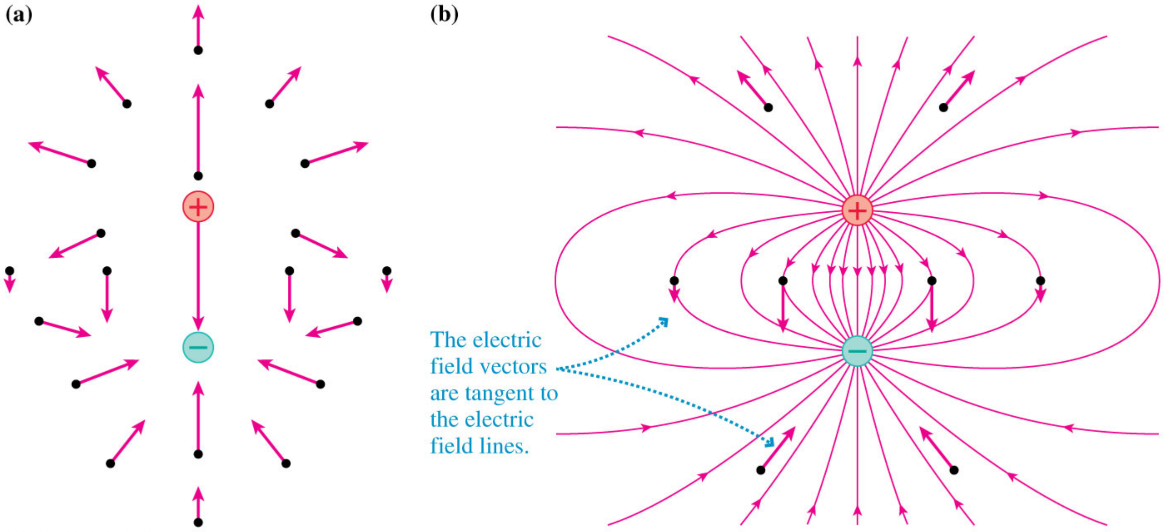
Two ways:

1. *Electric field vectors*
2. *Electric field lines*



# *Electric Field Line Rules:*

1. Lines start on + charges and end on – charges.
2. As lines get *closer*, fields get *stronger*.
3. Arrows point in direction of force on a *positive test charge*.
4. Force is *tangent* to field lines.
5. Field lines CAN'T cross.

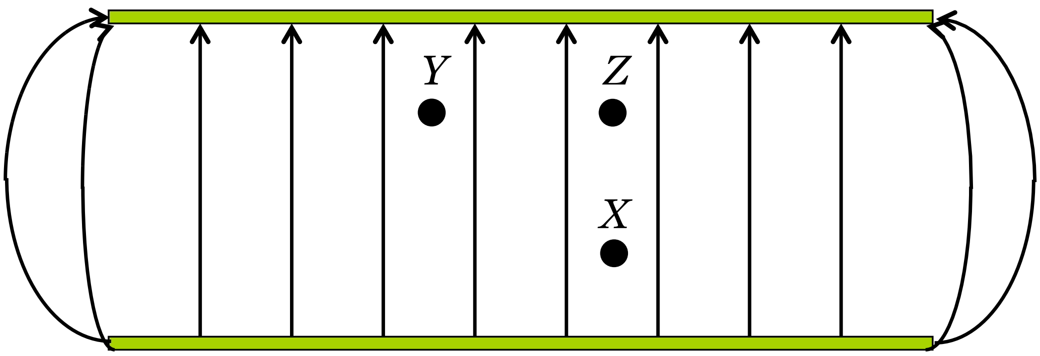





- Density of lines indicate field strength

# Quiz Question 1

The diagram shows the electric field lines due to two charged metal plates. We can conclude that:



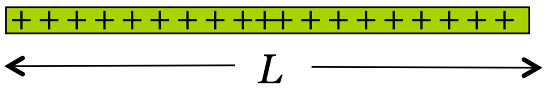

1. The upper plate is *positive* and the lower plate is *negative*.
2. A + charge at *X* would experience the *same* force if it were placed at *Y* or *Z*
3. A + charge *X* experiences a *greater force* than if it were placed at *Y* or *Z*.
4. A + charge at *X* experiences *less force* than if it were placed at *Y* or Z.
5. A - charge at *X* could have it's weight balanced by the electrical force.

# *Charge Densities*

Point Charge

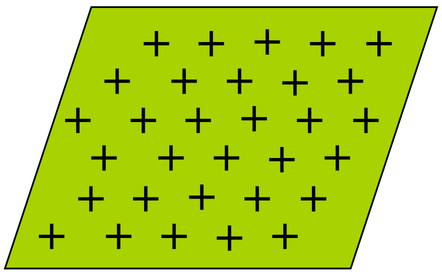
$$q$$

Line Charge




$$\lambda = \frac{Q}{L}$$

Surface Charge

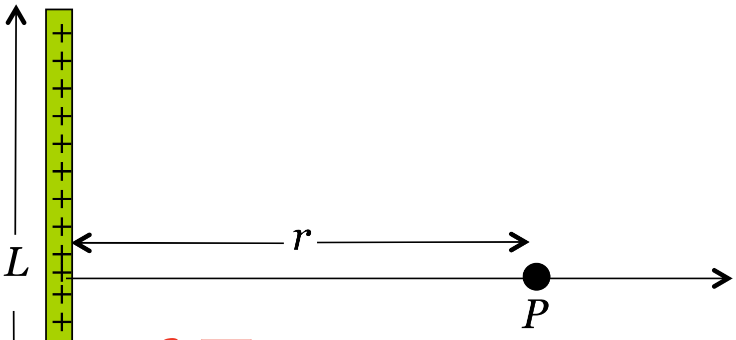


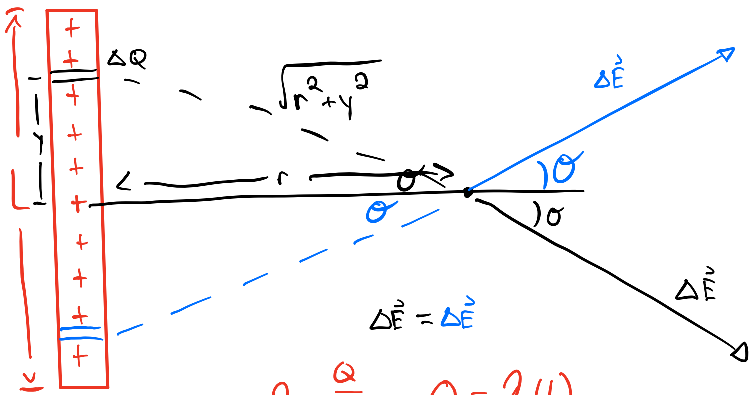
Area $A$

$$\eta = \frac{Q}{A}$$

# *i.e. 26.3*
# *E-field of a line of charge..*

Figure 26.11 shows a thin, uniformly charged rod of length *L* with total charge *Q*. Find the electric field strength at radial distance *r* in the plane that bisects the rod.

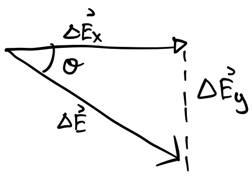



$\Delta\vec{E} = \Delta\vec{E}$

$\lambda = \frac{Q}{L}$ $\quad Q = \lambda(L)$

$\Delta Q = \lambda \Delta y$




X- component

$\Delta\vec{E}_x = \Delta E \cos\theta$

Notice: By symmetry the net or total electric field must point purely in the x-direction

$$\Delta\vec{E} = \frac{K\Delta Q}{r^2+y^2} = \frac{K\lambda\Delta y}{r^2+y^2} = \frac{K\lambda r\Delta y}{\sqrt{r^2+y^2}}$$

$$\cos\theta = \frac{r}{\sqrt{r^2+y^2}}$$

$$dE_x = \frac{K\lambda r\,dy}{(r^2+y^2)^{3/2}}$$

$$\Delta\vec{E}_x = \frac{K\lambda r\Delta y}{\sqrt{r^2+y^2}}$$

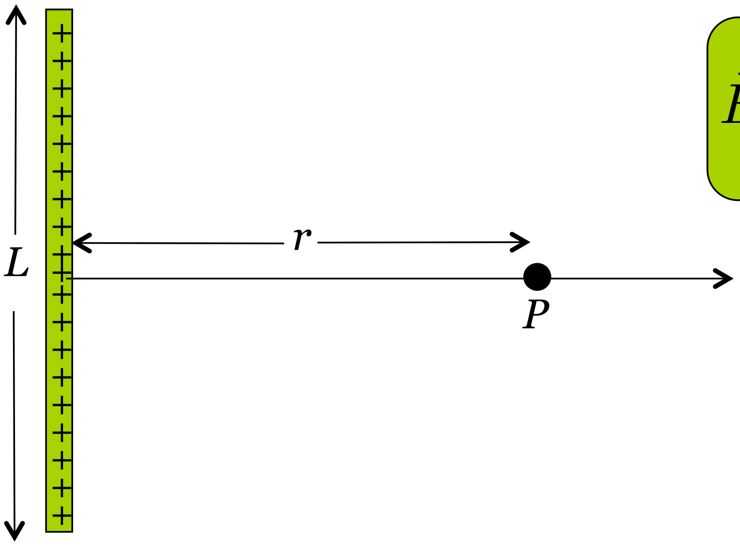
$$E_x = \int_{-\frac{L}{2}}^{\frac{L}{2}} \frac{K\lambda r\,dy}{(r^2+y^2)^{3/2}}$$

$$\vec{E} = \frac{KQ}{r\sqrt{r^2+L^2/4}}$$

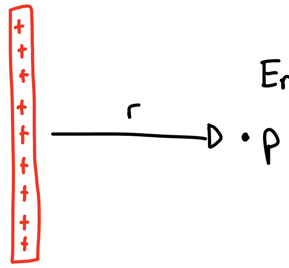
$$= K\lambda r \int_{-L/2}^{L/2} \frac{dy}{(r^2+y^2)^{3/2}}$$

# *i.e. 26.3*
# *E-field of a line of charge..*

Figure 26.11 shows a thin, uniformly charged rod of length $L$ with total charge $Q$. Find the electric field strength at radial distance $r$ in the plane that bisects the rod.



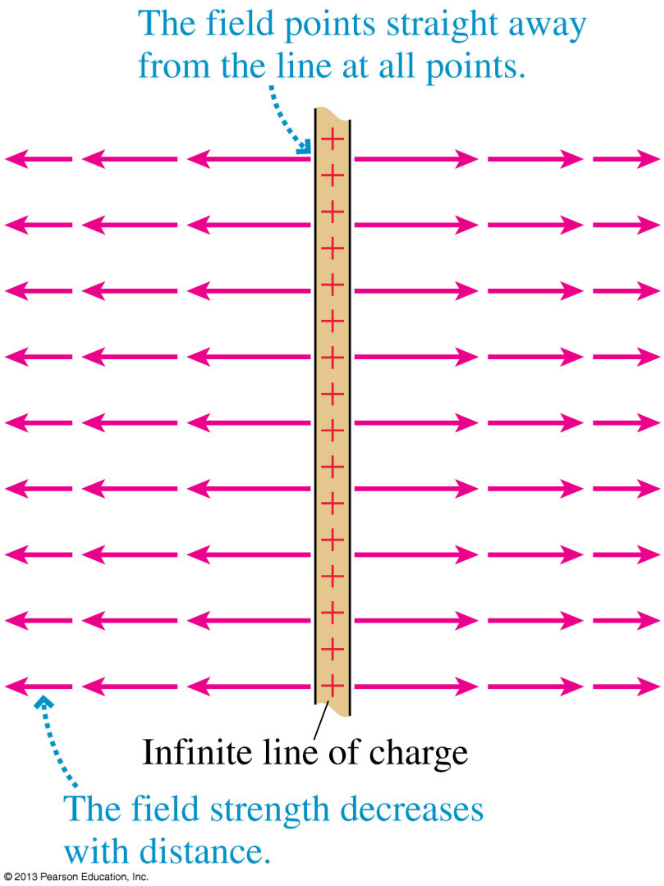

$$\boxed{\vec{E}_{rod} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r\sqrt{r^2 + L^2/4}}\hat{\imath}}$$



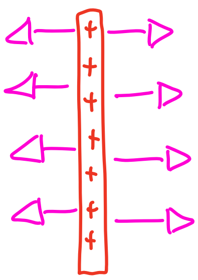

$$E_{rod} = \frac{KQ}{r\sqrt{r^2 + L^2/4}}$$

- Q: What if the rod becomes *infinitely* long?

# *E-field of a line of an infinite line charge..*




$$E_{line} = \frac{1}{4\pi\epsilon_0}\frac{2\lambda}{r}$$



Infinite

$$E_{inf} = \frac{2K\lambda}{r}$$